Fighting Inflation Within the Dollarization Context: The Case of Vietnam

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Abstract:

During the transition towards a market economy, the Vietnamese economy has embarked upon a path of lasting disinflation in a context of dollarization. In this study, a model shedding light on the determinants of inflation in the case of dollarization is developed and estimated with a two-step procedure for Vietnam in the 1990s. In particular, the results of this research reveal the impact on inflation of the exchange rate variations and a measure of the excess of broad money. Then, managing the exchange rate fluctuations and avoiding any excess of broadly defined money are found to be essential. The adoption of these two strategies by Vietnamese authorities may be a significant explanation of their ability to fight inflation.

JEL codes : E31, E41, E52

Keywords : inflation, demand for money, dollarization, cointegration, Vietnam.

1. Introduction

Dollarization, the holding of foreign currency denominated assets by domestic residents, becomes widespread in developing and transition economies. The implications of dollarization for the design of the monetary and exchange rate policies are discussed in Calvo and Végh (1997), Baliño et al. (1999) and Berg and Borensztein (2000). Overall, a fixed exchange rate should be preferred because under a floating regime high dollarization may increase exchange rate volatility, which is detrimental to financial and overall economic stability. For monetary policy based on money targeting, dollarization raises the question whether foreign currency should be included in the targeted monetary aggregate. This is essentially an empirical and country-specific issue, depending on the scale of dollarization and other financial conditions, although broader aggregates including foreign currency often prove more relevant. Previous country studies mostly focus on Latin American, transition or emerging economies. Vietnam has received little attention while partially dollarized it has followed a successful disinflation policy during its transition towards a market economy. This paper attempts to help understand how monetary and exchange rate policies may have contributed to the control of inflation in Vietnam.

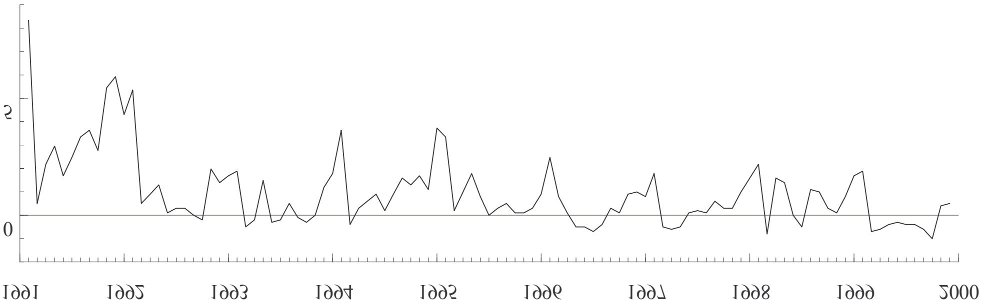
In Vietnam, the widespread circulation of US dollars appeared at the end of the 1960s when the American armed forces were based in the south of the country. Following the reunification of Vietnam in 1975, the holding of foreign currency by residents was strictly forbidden in order to reinforce the national currency unit, the dong (VND). Dollarization reappeared at the beginning of the transition towards a market economy, in the wake of the hyper-inflation in 1986-88 fuelled by a loose monetary stance and by the dramatic depreciation of the exchange rate (from VND/USD 15 at the end-1985 to VND/USD 3 000 at the end-1988). In 1988-89, following the removal of price control, the unification of exchange rate regime and the introduction of foreign currency deposits, the rise in interest rates on dong-denominated deposits induced a spectacular decline in inflation from 350% in 1988 to 35% in 1989. However, weak domestic credit control saw the money supply increase again and inflation increased to 67% in 1990 and 72% in 1991, while the dong depreciated to VND/USD 14 000 by the end of 1991. Dollarization culminated at the end of 1991.

The Vietnamese authorities decided to implement a shock-therapy approach in order to break the inflation-depreciation spiral (Guillaumont Jeanneney, 1994). They sold huge amounts of dollars on foreign exchange markets, causing an appreciation of the exchange rate from VND/USD 14 000 at the end-1991 to VND/USD 10 500 in January 1993. Together with the control of the monetary expansion, the authorities successfully pursued a policy of pegging the dong to the US dollar for the next five years. Dollarization process then reversed and the yearly average inflation rate remained below 10% (see Figure 1).

A weakening trade balance in 1995-96 raised the concern of an overvaluation of the dong and induced a speculative demand for dollars, which has been reinforced by the Asian crisis in 1997-98. The exchange rate came under pressure and the dong depreciated from VND/USD 11 000 at the end of 1996 to VND/USD 14 000 at the end of 1999. Since then, dollarization has been growing steadily[1], but inflation was kept under control.

[1] Foreign currency deposits and US dollar banknotes represent a substantial proportion of the total money supply in Vietnam. The exact volume of US banknotes in circulation is hard to determine precisely, but one source estimated it to be around USD 3billion in 2000, approximately 10 percent of GDP (Unteroberdoerster, 2002). Foreign currency deposits in the banking system have grown steadily since the mid-1990s to just under 35 percent in 2001. By the end of 2000, total foreign currency accounted for 42 percent of the total money in Vietnam (shares are: domestic currency in circulation 20%, domestic currency deposits 38%, foreign currency in circulation 16% and foreign currency deposits 26%, calculations from the author with data from IMF, 2002, and Unteroberdoerster, 2002). Foreign currency deposits held abroad by Vietnamese residents are negligible because of efficient

Fig. 1. Monthly inflation rate, Vietnam 1991-1999, in %.



Notes : in % by month. Sources : see appendix 1.

Firstly, during the 1990s the monetary authorities have demonstrated their preference for the exchange rate stability (Vo Tri Than, 1999, and State Bank of Vietnam *Annual Reports*). From 1993 to 1999, the exchange rate remained stable, except when it was devalued in the wake of the Asian crisis. Secondly, the restrictive monetary policy adopted since 1992 has been based on a broad monetary aggregate as an intermediate target of monetary policy. This aggregate, called M2 or total liquidity, is composed of the domestic money and foreign currency deposits held in the domestic banking system (State Bank of Vietnam *Annual Reports*)[2]. In this paper, it is suggested that these two strategies may explain the successful control of inflation in Vietnam. An analytical and empirical framework is then proposed to assess the contribution of the monetary and exchange rate policies to the control of inflation in the context of dollarization. This framework is tested for Vietnam in the 1990s. The paper is organized as follows. Section 2 presents the model of inflation, highlighting the impact of money and exchange rate in the context of dollarization. Section 3 presents the data and estimates using a two-step procedure. Section 4 concludes.

2. The model of inflation

2.1. The impact of the excess of broad money on inflation

When monetary authorities try to control money supply, they recognize that inflation is a monetary phenomenon, at least in part. The aim is then to avoid a too rapid monetary expansion which fuels inflation. Assessing the relevance of this policy often consist in

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restrictions (see International Monetary Fund, *Exchange Arrangements and Exchange Restrictions*, various issues).

[2] The restrictive monetary policy was preceded by the application of a hard budget constraint on the state-owned enterprises and on the government, which allowed the slowdown in the growth of the credit to the economy at the beginning of the 1990s. Then, backed by a low budget deficit, the State Bank of Vietnam mainly used restrictive banking credit ceilings in the 1990s to control the growth in M2.

estimating the impact of an increase in money supply on inflation. However, money supply expansion does not *per se* induces inflation, but only if it is not absorbed by an equivalent increase in money demand. In other words, the impact of an increase in money supply on inflation depends on the change in money demand, for instance on the change in economic activity or income. Therefore, an analysis in terms of *excess money* must be preferred.

In a dollarized economy, the choice of the most relevant concept of money is complex as the foreign currency denominated assets in circulation can be included in the measure of money or not. The following arguments lead to adopt a broad aggregate including foreign-currency-denominated assets held by residents.

First, in Vietnam, the US dollar partially replaces the dong as unit of account, means of exchange and store of value. A significant substitutability between the two currencies should then result. Moreover, when the foreign currency is used for transactions (Calvo and Végh, 1992, use the term *currency substitution* to describe this case), an excess of foreign currency should fuel the demand for goods and consequently inflation. In this case, the relevant concept of money should include foreign-currency-denominated assets.

Second, choosing the relevant money concept may come to the search of the empirical definition of money, i.e. the monetary aggregate showing the tightest link to the other economic variables. In previous studies on dollarized economies, broad monetary aggregates including foreign currency deposits often present the tightest link to inflation (see among others Baliño et al., 1999, Berg and Borensztein, 2000, Reinhart et al., 2003).

Finally, in the 1990s Vietnamese monetary authorities chose (the growth in) a broad monetary aggregate, M2, as an intermediate target of their monetary policy (see the State Bank of Vietnam *Annual Reports*). Hence, the empirical work is focused on this aggregate below.

2.2. The impact of the exchange rate on inflation in a dollarized economy

Whether the economy is dollarized or not, exchange rate variations affect domestic price of tradable goods expressed in domestic currency and consequently domestic inflation. If the economy is open, i.e. characterized by a large tradable goods sector, this impact justifies the authorities' willingness to manage exchange rate variations (the consequences of exchange rate regime on inflation are estimated in a cross-country study in Calderón and Schmidt-Hebbel, 2003, and for two small Asian countries in Cheung and Yuen, 2002). However, in the case of dollarization, exchange rate variations affect the domestic inflation through additional channels.

First, the price of some non-tradables is expressed in dollar: this is the case of durable goods and particularly the real estate in Vietnam. Therefore, the domestic-money-equivalent price of these goods is indexed on the exchange rate and exchange rate variations pass on the domestic inflation through a broader set of goods than in a non-dollarized economy.

Second, in the case of the dollarized economy, exchange rate variations make both the supply of and demand for money unstable. The exchange rate depreciation is an opportunity cost of holding domestic currency and a return of holding foreign currency. Therefore, the *expected* exchange rate depreciation, which can be assumed to depend on the actual depreciation, affects the demand for the domestic currency, or the relative demand for the two currencies, but should not affect the demand for broad money. However, when the concept of broad money is adopted, exchange rate variations affect the money supply as the domestic currency equivalent of foreign currency assets automatically varies with the exchange rate. Thus, exchange rate variations can affect the excess of money and inflation.

These particular elements in a dollarized economy reinforce the importance to manage the exchange rate variations, indeed even to choose the peg.

2.3. The model of inflation

The model is built in order to assess the impact of dollarization on inflation. Consequently, for areas which are beyond the scope of this work, the model contains simplified assumptions which are discussed for Vietnam. The model classically distinguishes two categories of goods in consumption, tradables (T) and non-tradables (NT). The consumer price index is then the weighted average of tradable and non-tradable prices and the domestic inflation rate is

$$\Delta p_t = \theta \Delta p^T{}_t + (1-\theta)\Delta p^{NT}{}_t \, , \qquad (1)$$

where small letters denote logarithm: p is the log of the consumer price index, p^T and p^{NT} are respectively the log of tradable and non-tradable prices. Δ is the first difference operator. θ is the constant weight of tradable price in the consumer price index with $0< \theta <1$. Only sparse information about the CPI weighting pattern is available which unable the calculation of a precise proxy for θ. [3] For a small economy – a price-taker country –, the tradable price mainly

[3] The problem is primarily due to the aggregation of food items which had a weight of over 60% in the CPI prior to July 2001 and may contain tradable as well as non-tradable goods. During the period under review, the weighting in the CPI was: food 61%, clothes and footwear 6%, household goods 5%, housing and construction 3%, transport and communications 7%, other items 18% (IMF, 2002). On the supply side, the share of the *tradable sectors in the GDP* can be computed roughly using annual GDP sectoral disaggregation published by the IMF (IMF, 1999 and 2002, tables 2 and 3).

depends on the international price expressed in domestic currency. The rate of change in the tradable price is thus

$$\Delta p^T_t = \lambda \Delta e_t + \mu \Delta p^W_t + \delta_T, \tag{2}$$

with e the log of the nominal exchange rate (units of domestic currency per unit of foreign currency); p^W the international price of tradables (in foreign currency) – p^T and p^W being prices of identical goods. δ is a constant capturing the difference between price index levels, or constant transportation and transactions costs, constant tariffs, or the possible violation of identical goods assumption. λ, μ are coefficients.

The coefficient λ is usually called the exchange rate pass through with $0<\lambda<1$ modeling an incomplete pass through of the devaluation to the local currency price of tradables. In this case, λ measures the variable markup of tradable price over international price following a change in the exchange rate. An incomplete pass through for tradables may reflect price stickiness or imperfect competition. In the recent empirical literature, discussions about the pass through incompleteness have focused on imperfect competition in trade between industrialized countries at the industry level (see Rogoff 1996 and Goldberg and Knetter 1997 for a review of the literature). Usually however, it is found that the smaller and the less developed the economy, the more complete the pass through must be (Feinberg, 2000, Ghei and Pritchett, 1999). Giving the small size of the Vietnam economy, when compared to its main trade partners and its medium income neighbors, a high exchange rate pass through should be expected (exporters to Vietnam and Vietnamese importers mainly follow a mark-up pricing strategy). As an extreme case, assuming $\lambda=\mu=1$, a simplified version of (2) emerges

$$\Delta p^T_t = \Delta e_t + \Delta p^W_t + \delta_T, \tag{2'}$$

Equation (2') states that the *relative* law of one price (LOOP) holds for tradables. The pass through is then complete for tradables, which derives from a strict – or textbook – definition of tradability; in the same sense, the pass through should be null for non-tradables. However, Equations (2) and (2') similarly reveals two foreign sources of the domestic inflation: the change in the exchange rate and the change in foreign prices.

The non-tradable price is mainly determined by supply of and demand for non-tradables in the domestic economy. The main factor of non-tradable inflation is assumed to be excess

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Assuming that tradables consist of primary and manufacturing sectors, the share of tradables in the GDP has been stable from 1991 to 1999 (ranging between 46% and 50% with an average of 48%). On the other hand, assuming that tradables consist of primary and non-state owned manufacturing sectors (most of the state-owned enterprises which account for around 50% of the industrial sector have been supported by authorities' protection, some of them by import quotas or bans), the share of the tradables in the GDP ranged from 38% to 42% with an average of 40%. Details are available on request.

money, i.e. the difference between the actual money holdings and the long-run desired level of money. If individuals hold a more than desired amount of money at the beginning of the actual period, they adjust their holdings by buying goods during the actual period thus fueling the demand and eventually inflation. However, a partial adjustment should take place as a result of the adjustment and the transaction costs and uncertainties about expectations. If individuals desire to hold a given amount of *real* money, let the excess money be defined as

$$EC_t = (m\text{-}p)_t - (m\text{-}p)_t^* \,, \tag{3}$$

with m = log(M) and M nominal money. The desired money balances $(m\text{-}p)^*$ is defined as the long-run demand for money which depends on a vector of variables X,

$$(m\text{-}p)^*_t = \beta' X_t \,, \tag{4}$$

with β the vector of the long-run parameters and X the vector of demand-for-money determinants. The Representation Theorem (Engle and Granger, 1987) allows the shift from the long-run relation (4) to the (short-run) Error Correction specification

$$\Delta(m\text{-}p)_t = \alpha\,[\,(m\text{-}p) - (m\text{-}p)^*\,]_{t-1} + \sum_{i=1}^{k-1} \gamma_i\, \Delta(m\text{-}p)_{t-i} + \sum_{j=0}^{k-1} \delta_j\, \Delta X_j \,, \tag{5}$$

Equation (5) states that short-run changes in money balances depend on short-run shocks affecting X and on the excess money correction (of α per period). In other terms, money holders eliminate a proportion α of excess money, which fuels the demand for goods. Furthermore, if the excess money does not affect the supply of goods in the short-run (this may be tested afterwards), the increase in the non-tradable goods price is proportional to α.

Other sources of non-tradable inflation might include structural reforms which certainly affect the inflation path during the transition to a market economy. However, significant structural reforms in Vietnam have been adopted before the period under review, as the liberalization of all prices, except of some public services, which took place as soon as 1988-1989. Reforms in the State-owned-enterprises (SOEs) sector were dramatic in the late 1980s, but they progressed slowly in the 1990s.[4] During this period, SOEs were not significantly exposed to competition and benefited from large amount of foreign direct investment and development aid without major changes in their management methods (IMF, 1999 and World Bank, 1999). Then, changes in the competitive pressure on firms seem to have been moderate during the 1990s even if is hard to assess due to the lack of data.

As regards the labor market, data are unreliable given the large share of the informal employment. However, unemployment rate in urban areas and underemployment in rural

[4] The number of SOEs was dramatically reduced from 12,000 to 6,000 in 1989-92 mainly from mergers, lowered employment by more than one a third.

areas has been high in the 1990s (see Chandrasiri and de Silva, 1996, CIEM, 1999, and World Bank, 1999). As a large reserve of underemployed labor from agriculture and rural sector should induce a moderate increase in the overall wage level in the economy, the labor market was certainly not a significant source of inflation in the 1990s.

As discussed above, changes in the exchange rate automatically pass on the domestic inflation through the dollar denominated price of particular non-tradables in the dollarization context. Consequently, the rate of change in the exchange rate is included as a source of non-tradable inflation. Exchange rate variations might also affect non-tradable inflation through the impact of the relative price of tradables on non-tradables, i.e. the real exchange rate, on consumption. However, to keep the model tractable a low degree of substitution between the two categories of goods is assumed (relaxing this hypothesis would not imply a modification of the reduced form equation of inflation (8) above). A full set of seasonal dummies is also included among determinants[5].

Then, the equation for the change in the non-tradable price is

$$\Delta p^{NT}_t = \alpha EC_{t-1} + \gamma' S_t + \zeta \Delta e_t + \delta_{NT} , \qquad (6)$$

where γ is a vector of parameters and S_t a vector of seasonal dummies. ζ gives the impact of the indexation of the dollar denominated price of particular non-tradables; Assuming a one-for-one response of the domestic currency price of these goods to the exchange rate, ζ is then only the share of these goods in the consumption of non-tradables.

Substitution of (2) and (6) into (1) gives

$$\Delta p_t = (\lambda\theta + (1-\theta)\zeta)\Delta e_t + \theta\mu\Delta p^W_t + (1-\theta)\alpha EC_{t-1} + (1-\theta)\gamma' sais_t + \delta , \qquad (7)$$

and assuming the LOOP for tradables, substitution of (2') and (6) into (1) gives

$$\Delta p_t = (\theta + (1-\theta)\zeta)\Delta e_t + \theta\Delta p^W_t + (1-\theta)\alpha EC_{t-1} + (1-\theta)\gamma' sais_t + \delta , \qquad (7')$$

Equation (7) or (7') shows that the impact of EC depends on the speed of correction and on the weight of the non-tradables price in the consumer price index. Equation (7') clearly suggests that the impact of the exchange rate should be higher than the impact of the international price of tradables on domestic inflation and allows an easy derivation of ζ if θ is known.

Equation (7) or (7') leads to the reduced-form inflation equation

$$\Delta p_t = \kappa 1.\Delta e_t + \kappa 2.\Delta p^W_t + \kappa 3.EC_{t-1} + \kappa 4.S_t + \delta , \qquad (8)$$

with $\kappa 1, \kappa 2, \kappa 3 \in [0,1]$, which is estimated with a two step procedure in the following section.

[5] In particular, before and during the Lunar New Year celebrations in January-February of every year, inflation accelerates as the consumer goods demand increases.

3. Estimations and tests: Vietnam 1991-1999

The estimation method was previously used by Juselius (1992) and Metin (1995), which address the difficulties of interpreting large cointegration spaces and of dealing with small samples[6]. Cointegration is first investigated in the monetary sector { (m-p) , X }, and consequently excess money is calculated. Second, the equation of inflation (8) is estimated using the measure of excess money[7].

3.1. The monetary sector { (m-p) , X }

The money aggregate M2 consists of the dong in circulation, dong-denominated and dollar-denominated deposits, and the price index is the consumer price index. Long-run demand-for-money determinants comprise the real economic activity, proxied by the index of monthly industrial output, the only monthly reported activity index in Vietnam. Expected inflation is usually the preferred opportunity cost in money demand studies in developing countries (see Sriram, 2001, for a recent review). However, M2 holdings could be invariant to the expected inflation rate since it includes foreign currency deposits that constitute a hedge against depreciation and inflation (if exchange rate depreciation and inflation are linked, foreign currency deposits are used as a store of value). This will be tested by including the actual inflation rate (as a proxy for the expected rate under perfect foresight) in the determinants of the demand for M2. [8, 9] Data have been obtained from the State Bank of Vietnam and cover the period from January 1991 to June 1999, giving 102 data points for estimation. Details on data and results of the augmented Dickey-Fuller test are noted in the appendix A. The null hypothesis of one unit-root is accepted for variables with the exception of the inflation rate. However, Johansen indicates that one can include stationary variables in

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[6] This method is also recently used by Durevall and Ndung'u (1999), Jonsson (1999), Nachega (2001), Sacerdoti and Xiao (2001) and Sekine (2001).

[7] When studying the Danish inflation, Juselius (1992) investigates cointegration relationships in the domestic labor market, monetary sector and foreign sector. Our preliminary results of the cointegration analysis in the foreign sector between domestic price, foreign price and exchange rate are inconclusive suggesting that purchasing power parity is irrelevant for a transition economy such as Vietnam.

[8] The expected depreciation could be an opportunity cost for M2 as it could lead to a substitution not only between the components of M2 but also possibly between M2 and dollar banknotes, which are excluded from M2. The inclusion of the depreciation rate in the cointegration analysis of the monetary sector has proved insignificant.

[9] Financial system is relatively under-developed in Vietnam. The only available interest rate for 1991-1999 on a monthly frequency is the three-months dong deposits interest rate, which is a yield for these deposits but an opportunity cost for the other components of M2. As every interest rate in Vietnam, this rate was administrated during the 1990s and shows only small variations. Preliminary results suggest that this interest rate do not affect money demand.

the cointegrating space if one supposes they can affect the long-run relationships[10]. A cointegration framework is therefore employed for analysis of the vector Y= {(m2-p) , y, Δp}.

A vector error-correction model (VECM) is estimated, which is a generalization of the equation (5), allowing the tests for the number of cointegrating vectors and the variables endogeneity,

$$\Delta Y_t = \alpha\, \beta'\, Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i\, \Delta Y_{t-i} + D_t + \varepsilon_t \qquad (9)$$

with Y = {(m2-p) , y, Δp}, β' denotes the matrix of parameters of the cointegrating vectors ($\beta' Y_{t-k}$ are error-correction terms), and α the matrix of equilibrium-correction or feedback effects. Γ_i is the matrix of short-run parameters. D_t denotes deterministic components. A lag length *k=6* fully captures the dynamics between the variables of the vector Y and renders the vector of error-terms ε_t approximately Gaussian[11].

Full results of the cointegration analysis are reported in appendix B. Residual-based tests indicate the absence of serious statistical misspecification of the underlying vector autoregression. *Trace* tests suggest the presence of two cointegrating vectors.

Neither is immediately interpretable, although one of the cointegrating vectors would appear to be broadly consistent with the long-run demand for money function with an income elasticity near unity. The other vector dominated by the coefficient of Δp indicates the multivariate stationarity of inflation, as it has been suggested by the univariate unit root tests.

The preceding features point to the following restrictions on the cointegrating space which are tested by mean of the likelihood ratio test. Conditional on the cointegrating rank being *r=2*, the normalization of the two cointegrating vectors β1 and β2 on (m2-p) and Δp respectively is first imposed. Δp stationarity is then formulated in β2. Given that inflation hedging assets are included in M2, the exclusion of Δp from β1 is tested. These restrictions on

[10] However, including a stationary variable in the cointegrating space systematically add a cointegrating vector which contains only this stationary variable. See Johansen and Juselius (1990) and Johansen (1995) chapter 5 p.74.

[11] Preliminary results suggest that the deterministic components should be a constant restricted to the long-run relationships, unrestricted (centred) seasonal dummies but no deterministic trend. In the underlying VAR, the deterministic trend has proved insignificant at usual levels when D_t include a trend and an unrestricted constant (F=1.37 [0.26]). Furthermore, Trace tests are respectively:

H0: rank ≤	Constant unrestricted Trend restricted	Constant unrestricted No trend	Constant restricted No trend
0	29.607 [0.531]	23.481 [0.231]	46.456 [0.002]**
1	15.560 [0.536]	10.042 [0.283]	22.500 [0.022]*
2	6.3580 [0.427]	0.8740 [0.350]	9.1335 [0.059]

β are accepted (the Likelihood Ratio test has a value of $\chi2(2) = 1.91$ [0.38]). The weak exogeneity of y *vis-à-vis* $\beta1$ is then tested and accepted, and identification is attained with the restriction that (m2-p) do not respond to $\beta2$.

To clarify the set of identifying restrictions, let the VECM be:

$$\Delta Y_t = \alpha\, \beta'\, Y_{t-6} + (\ldots) \tag{9}$$

with

$$\Delta Y = \begin{pmatrix} \Delta(m2-p) \\ \Delta y \\ \Delta\Delta p \end{pmatrix} \quad \alpha = \begin{pmatrix} \alpha_{11} & \alpha_{21} \\ \alpha_{12} & \alpha_{22} \\ \alpha_{13} & \alpha_{23} \end{pmatrix} \quad \beta' = \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & c_1 \\ \beta_{21} & \beta_{22} & \beta_{23} & c_2 \end{pmatrix} \quad Y = \begin{pmatrix} (m2-p) \\ y \\ \Delta p \end{pmatrix}$$

with the first subscript denoting the cointegrating vector i (i=1,2) and the second denoting the variable j (j=1,…,3 respectively for (m2-p), y, and Δp).

The complete set of restrictions is represented in the following restricted matrix:

$$\alpha_r = \begin{pmatrix} \alpha_{11} & 0 \\ 0 & \alpha_{22} \\ \alpha_{13} & \alpha_{23} \end{pmatrix} \qquad \beta_r' = \begin{pmatrix} 1 & \beta_{12} & 0 & c_1 \\ 0 & 0 & 1 & c_2 \end{pmatrix}$$

which is accepted ($\chi2(7) = 4.10$ [0.25]). Appendix B reports the results from estimating α_r and β_r, leading to the restricted long-run demand-for-money function taking the form

$$(m2-p)_t = 1.16\, y_t - 3.51$$

with a feedback coefficient on $\Delta(m2-p)_t$ of $\hat{\alpha}_{11}=-0.18$.

The income elasticity is above the unity indicating the monetarization process in Vietnam, and M2 demand does not respond to the expectations of inflation[12]. Regarding the monetary policy, this result suggests that targeting M2 requires the anticipation of economic activity only, while targeting a domestic currency aggregate would require, arguably, to take into account the inflation or exchange rate depreciation in the case of dollarization.

Concerning the feedback coefficients *vis-à-vis* the first cointegrating vector, agents significantly correct the excess money by about 18% per month. The variable y is weakly exogenous, i.e. is not affected by excess money. Inflation responds to excess money with a marginally significant link; this will be investigated more thoroughly in the following section where other determinants of inflation are took into account.

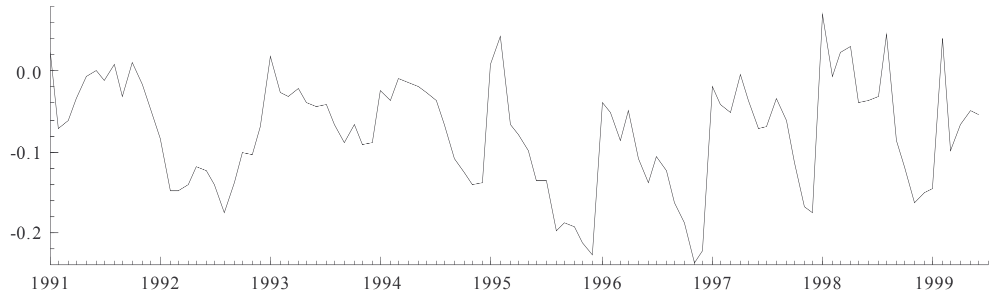
The excess money is

[12] Similar results are obtained from the analysis of the alternative vectors {(m2-p) , y, Δp, Δe}or {(m2-p) , y, Δe}.

$$ECm2_t = (m2\text{-}p)_t - 1.16\, y_t - 3.51$$

which is reported in the next graph where a drop in the excess money is observed just before the disinflation in 1992.

Fig. 2. Excess money



Notes : $ECm2 = (m2\text{-}p)_t - (m2\text{-}p)_t^*$

3.2. The short-run dynamics of inflation

The excess money ECm2 being calculated, determinants of inflation are investigated with the estimation of equation (8)

$$\Delta p_t = \kappa 1.\Delta e_t + \kappa 2.\Delta p^W{}_t + \kappa 3.EC_{t-1} + \kappa 4.sais_t \qquad (8)$$

Given that export or import unit values are unavailable, proxies for the international price of tradables Δp^W are used. First, a measure of foreign inflation is computed as a weighted mean of inflation rates of the 10 countries which are the main commercial partners of Vietnam[13]. Second, as rice is a tradable (exportable) good[14] and takes a significant share in the domestic consumption in Vietnam, a dollar-denominated export price of the Vietnamese rice is used, which is readily available and a good proxy for the international price of this tradable good. Furthermore, this export price can be considered as exogenous given that although Vietnam is one of the largest rice exporting countries, it cannot be considered as a *price-maker* in the world market.

Given the often-met lags of adjustment in monetary dynamics, a general ARDL specification is used, of the form

$$\Delta p_t = \sum_{i=1}^{k} \eta_i\, \Delta p_{t-i} + \sum_{j=0}^{k} K_j\, V_{t-j} + u_t \qquad (10)$$

[13] A shortcoming of using inflation rates is that consumer price indexes include non-tradable goods consumed in foreign countries. Moreover, tradable goods consumed in foreign countries can be different from those consumed in Vietnam.

[14] High export prices sometimes diverted domestic supply resulting in an increase in the domestic price, see Dodsworth et al. (1996).

with the vector of stationary variables V = { Δe , Δp^W, EC , constant, sais } and the associated vector of short-run coefficients K = { κ1, κ2, …}. Including various lags of EC_t (EC_{t-j} with j=0,…,k) allows to test whether EC_{t-1} (one-period-lagged EC) is relevant when monthly data are used.

The use of either the foreign inflation or the rice export price for Δp^W leads to similar results, but estimates with the latter are reported because it demonstrates a tighter link to inflation. From an initial k=6, a simplification procedure *à la* Hendry is adopted to obtain parsimony without erroneous exclusion. The following table reports alternative OLS estimates[15].

Table 1 - Inflation equation estimates (OLS). Dependent variable is Δp_t.
1991:08 – 1999:06. T=95.

	[1]	[2]	[3]
included monetary variables:	Excess broad money ECm2	money supply Δm2	Excess domestic money ECm2d
constant	0.004 (3.41)	0.000 (0.24)	0.002 (1.66)
Δp_{t-1}	0.39 (5.02)	0.42 (5.89)	0.40 (4.46)
Δp_{t-4}	0.30 (4.15)	0.26 (3.97)	0.26 (3.32)
EC_{t-1}	0.03 (2.64)	-	0.00 (0.86)
Δm_{t-2}	-	0.05 (1.99)	-
Δe_t	0.06 (2.11)	0.07 (2.42)	0.07 (2.00)
Δe_{t-3}	0.09 (3.12)	0.11 (3.64)	0.11 (3.61)
$\Delta rice_t$	0.03 (1.95)	0.03 (1.95)	0.03 (1.84)
R^2	0.849	0.844	0.836
DW	2.02	1.95	1.99
AR(1-6)	0.45[0.84]	0.37[0.89]	0.27[0.94]
ARCH(1-6)	0.79[0.57]	0.89[0.50]	0.98[0.43]
J-B	4.91[0.09]	6.23[0.04]*	5.48[0.06]
H	1.17[0.30]	0.96[0.51]	1.04[0.42]
RESET	2.87[0.09]	2.94[0.12]	4.71[0.03]*
Inst-var	0.10	0.10	0.08
Inst-joint	3.43	3.13	3.36

Notes: Coefficient of seasonal dummies variables not reported. HCSE-t-value in brackets. DW is the Durbin-Watson statistic. AR(1-6) and ARCH(1-6) are tests against the null of autocorrelation and autoregressive conditional heteroscedasticity of order 1 to 6. H and J-B are tests against the null of homoscedastic and normally-distributed errors. RESET is the regression stability test. Inst-var and Inst-joint are Hansen's tests for variance and joint parameter stability. Figures in square brackets [..] are tests statistics marginal significance levels. See for details the Pc Give 10.0 Manual by Hendry and Doornick (2001).

[15] Similar results are obtained when the instrumental variables estimator is used.

The first estimate [1] is the parsimonious specification after exclusion of insignificant regressors. Residuals based tests do not detect statistical misspecification and the goodness-of-fit is high with $R^2 = 0.85$. The inflation process demonstrates inertia with significant lagged inflation rates, implying that the short-run impact of the regressors is significant but weak. Coefficients have the expected sign.

Seasonal dummies which are not reported are jointly significant with $F(11,77) = 13.1$ [0.00], showing the seasonal component of inflation. The foreign sources of inflation are shown by the significant impact of the exchange rate depreciation and of the rice export price[16]. The former has a stronger impact, which can be induced by the expected additional impact of the exchange rate changes through the dollar-denominated price of particular non-tradable goods.

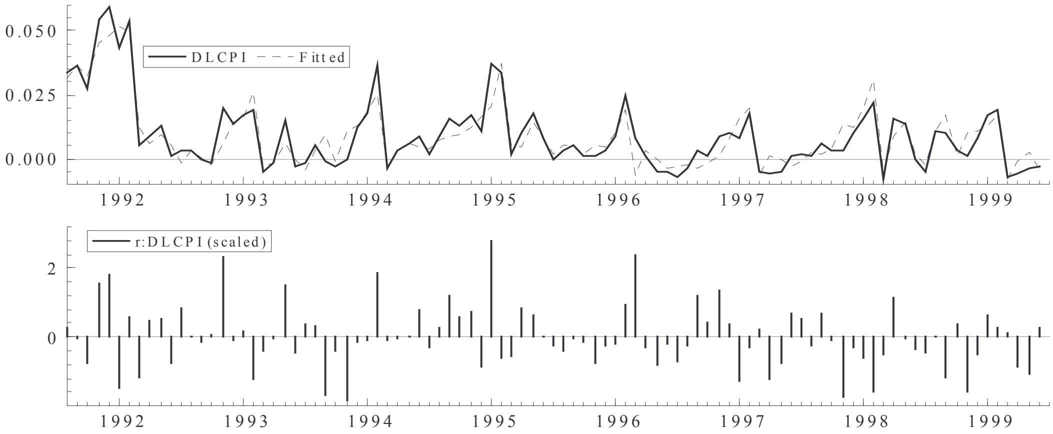
The estimated exchange rate pass-through coefficient is (0.06+0.09)/(1-0.39+0.30)=0.49, which is comparable to estimates in cross-country studies on developing and dollarized economies[17]. From Equation (7), the exchange rate pass-through is $(\lambda\theta + (1-\theta)\zeta)$ with θ the share of tradables in the CPI (θ estimates ranging from 40% to 48%, see footnote 3), λ the exchange rate pass-through for tradables, and ζ the share of the dollar-denominated-price non-tradable goods in the non-tradable category. Under the LOOP for tradables, $\lambda=1$, the additional impact of the exchange rate variations through the dollar-denominated price of particular non-tradable goods $(1-\theta)\zeta$ should range from 1 to 9 percentage points. Then, ζ the derived share of the dollar-denominated-price non-tradable goods in the non-tradable category should be comprised between 2% and 15%. If the pass through for tradables is incomplete, $\lambda=0.9$ for example, the additional impact of the exchange rate variations should range from 6 to 13 percentage points and the share of the dollar-denominated price non-tradable goods in the non-tradable category from 11% to 22%.

The one-period-lagged excess money $ECm2_{t-1}$ has a significant impact, showing that current inflation is affected by the correction of excess money observed at the end of the preceding month (the excess money being determined by previous excesses and by short-run shocks). The short-run effect of $ECm2_{t-1}$ is weak, with a coefficient of 0.03: a 1-percentage point decrease in EC induces a fall in inflation rate of 0.03 percentage point. This weak impact is explained by inflation inertia and, that only a proportion α of excess money fuels the demand for goods and inflation in the current period (α was previously estimated at 18% per

[16] The use of the instrumental variables estimator gives similar results, except that rice export price is less significant, indicating that it is not perfectly exogenous.
[17] See for instance Honohan and Shi (2001) and Reinhart et al. (2003).

month). The actual inflation rate and the fitted rate from [1] are reported in the following graph.

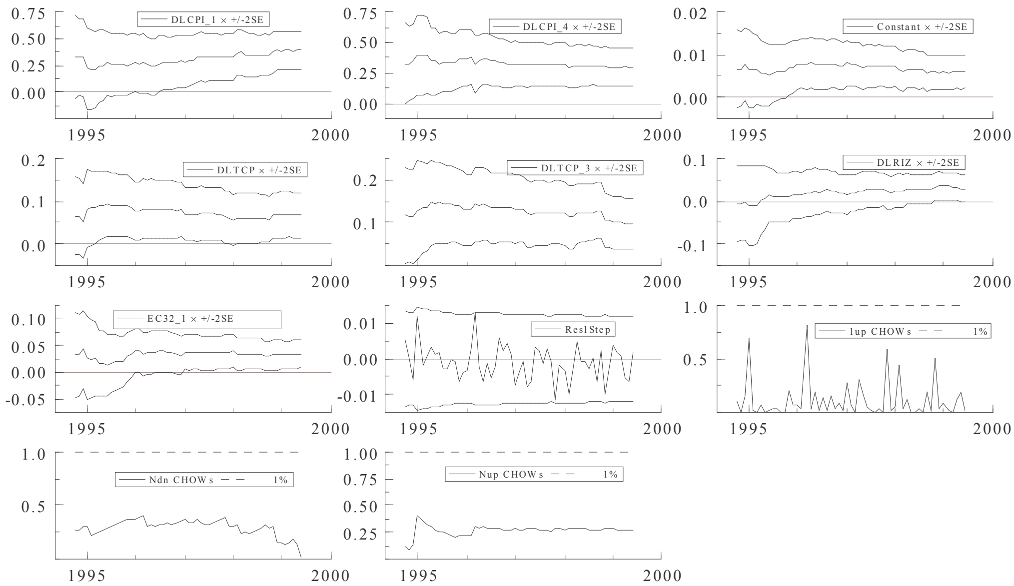
Fig. 3. Fitted and actual inflation rate and residuals.



Notes : actual Δp and fitted Δp from specification [1] reported in the first graph. Residuals (actual Δp minus fitted Δp) reported in the second graph.

Stability tests from recursive least-square estimates which are reported in the following graph do not reject the final specification [1]. Recursive coefficients and residuals are stable laying within the ± 2-standard-errors band and Chow tests do not detect significant instability.

Fig. 4. Specification [1]: coefficient constancy tests and specification stability tests.



Notes : The seven recursively estimated coefficients and the ±2 standard errors band; 1-step ahead residuals; 1-step forecast Chow test (1-up); Break-point Chow test (N-down); Forecast Chow test (N-up). See for details the Pc Give 10.0 Manual by Hendry and Doornick (2001).

Turning to alternative estimates, the rate of change in money supply is first substituted for EC, allowing to test that inflation is not affected by money supply but by excess money. From a general ARDL and after simplification, only the two-period-lagged money supply is significant but is weakly significant compared to excess money in the specification [1], confirming that the latter is a better representation of the monetary source of inflation. Whereas the explicative power of the specification [2] is good, this specification is rejected by the error normality test. Encompassing tests reported in the following table marginally confirm that the specification [1] encompasses the specification [2].

Table 2 Encompassing tests statistics.

Specification [1] {Δp,ECm2} versus Specification [2] {Δp, Δm2}.

		Spec. [1] ∈ Spec. [2]	Spec. [2] ∈ Spec. [1]
Cox	N(0,1)	-6.09 [0.00]**	-11.2 [0.00]**
Ericsson IV	N(0,1)	5.33 [0.00]**	9.69 [0.00]**
Sargan	Chi^2(1)	3.07 [0.08]	5.16 [0.02]*
Joint Model	F(1,76)	3.16 [0.08]	5.46 [0.02]*
sigma[Spec.1] = 0.0059		sigma[Spec.2] = 0.0061	sigma[Joint] = 0.0059

Notes : Tests are respectively Cox (1961), Ericsson (1983) and Sargan (1959) based on the instrumental variables method, and the F-test that each specification is a valid simplification of the linear combination of the both. Instruments are the other regressors. The null hypothesis is H0 : specification i encompasses (∈) specification j. See for details the Pc Give 10.0 Manual by Hendry and Doornick (2001).

Finally, the relevance of M2 is tested versus a domestic money aggregate denoted M2D, which consists of the dong in circulation and of dong-denominated deposits (i.e. M2 excluding foreign currency deposits)[18]. The cointegration analysis of the vector {(m2d-p), y, Δe, Δp} is reported in details in the appendix B. Inflation and depreciation expectations are found to be significant opportunity costs for domestic money demand. The function of the domestic money demand is

$$(m2d-p) = 1.10y - 4.72\Delta e - 10.7\Delta p - 3.06$$

This suggests that, contrasting with broad money, adopting the domestic money as an intermediate target for monetary policy would be uneasy since it requires to account for inflation and depreciation expectations. In this context, if authorities adopt a monetary aggregate as an intermediate target, the target should be a broad aggregate including inflation and depreciation hedging assets. The excess of domestic money is

$$ECm2d = (m2d-p) - 1.10y + 4.72\Delta e + 10.7\Delta p + 3.06$$

[18] Results from the analysis with narrower concepts of money, which are M0 (domestic currency in circulation) and M1 (M0 plus domestic currency demand deposits), indicate that their links with inflation are insignificant.

which substitutes for ECm2 in the inflation equation and, after simplification, the specification reported in the column [3] is obtained. The Ramsey RESET detects instability and ECm2d has no significant impact on inflation. A broad money aggregate seems then more relevant according to the link with inflation.

As the Vietnamese monetary authorities have adopted M2 as an intermediate target during the 1990s, this can partially explain why the final target of disinflation was met. Moreover, since the exchange rate variations automatically affect the broad money supply, the exchange rate management is found to be necessary to control monetary expansion.

As an illustration, from the specification [1] the impact of the exchange rate depreciation on inflation can be roughly computed for the years 1997-1998. The static long-run solution of the dynamic process [1] is [19] :

$$\Delta p = 0.004 + 0.39\Delta p + 0.30\Delta p + 0.03EC + 0.06\Delta e + 0.09\Delta e + 0.03\Delta rice$$

$$\text{so is } \Delta p = 0.01 + 0.1EC + 0.5\Delta e + 0.1\Delta rice$$

In 1997-1998, Vietnamese authorities have allowed exchange rate to depreciate by around 25%. Given that the share of foreign currency deposits in M2 was in this time about 20%, the depreciation induced a 5% increase in M2[20]. To isolate the depreciation impact, the money supply, apart from the effect of the depreciation, is assumed to increase at the same rhythm than the demand for money: the increase in M2 due to the depreciation then induce an additional excess of money of around 5% conditional to a weak initial excess of money[21]. The depreciation should then generate an additional inflation of

$$\Delta p = 0.1\times 5\% + 0.5\times 25\% = 0.5\% + 12.5\% = 13\%$$

This estimated additional inflation for 1997-1998 is very close to the accumulation of observed inflation in these years (annual inflation rate was 3.6% in 1997 and 9.2% in 1998)[22]. This brief accounting indicates that depreciation affected inflation mainly through the tradable goods price and through the dollar-denominated price of particular non-tradable goods. The impact of the depreciation through the excess money was weak, but certainly would have been more important if dollar banknotes in circulation were taken into account.

[19] See Hendry (1995) pp.212-214.

[20] Assuming that the monetary authorities do not react against this increase.

[21] With EC_0 the initial money excess in real terms, which simplifies in nominal terms to $EC_0=(M2-M2^*)/M2^*$ and thus $M2=M2^*(1+EC_0)$, and with g the rate of increase in the supply of and the demand for money, the additional excess money is $\{[M2^*(1+EC_0)(1+g)(1+5\%)–M2^*(1+g)]/ [M2^*(1+g)]\} – EC_0$ which simplifies to $(1+EC_0)5\%$.

[22] Moreover, the mean rate of change in the rice price was very weak in this period.

4. Conclusion

In this work, the determinants of inflation in Vietnam are investigated. Beside particular elements, such as the rice export price, the results emphasized that inflation is explained by exchange rate changes and by excess of money. The relevant concept of money should include foreign currency deposits in the domestic banking system. This is in line with earlier studies on other dollarized economies where broad money aggregates also displayed a tighter link to inflation. This conclusion is important especially in developing countries with relatively thin financial markets where a monetary aggregate is required as an intermediate target of monetary policy. Given the automatic impact of exchange rate variations on broad money supply, an additional implication is that control of the monetary expansion requires exchange rate control. Moreover, we highlighted the additional impact of exchange rate variation on inflation through the dollar-denominated price of some non-tradable goods. Overall, we showed that dollarization makes the control of exchange rate more desirable, even in a context of moderate inflation like Vietnam experienced in the 1990s.

Exchange rate management coupled with a restrictive monetary policy based on a broad concept of money are clearly found as a possible explanation of lasting disinflation. Vietnam should then be considered as a case of a good design of monetary and exchange rate policy. Finally, the analytical and empirical framework presented in this paper is simple enough to examine the consequences of dollarization on the conduct of monetary policy in a wider range of developing and transition countries.

References

Baliño, Tomas J.T, Bennett, Adam, Borensztein, Eduardo, 1999. Monetary policy in dollarized economies. International Monetary Fund Occasional Paper 171.

Berg, Andrew, Borensztein Eduardo, 2000. The choice of exchange rate regime and monetary target in highly dollarized economies. International Monetary Fund Working Paper 00/29.

Calderón, César, Schmidt-Hebbel, Klaus, 2003. Macroeconomic policies and performance in Latin America. Journal of International Money and Finance 22. 895-923.

Calvo, Guillermo A., Végh, Carlos A., 1992. Currency substitution in developing countries: an introduction. Revista de Analisis Economico, 7. 3-28.

Calvo, Guillermo A., Végh, Carlos A., 1997. From currency substitution to dollarization and beyond: analytical and policy issues. In: Calvo, Guillermo A. (Ed.) Essays on Money, Inflation and Output. MIT Press, Cambridge, MA.

Calvo, Guillermo A., Végh, Carlos A., 1992. Currency substitution in developing countries: an introduction. Revista de Analisis Economico, 7. 3-28.

Central Institute for Economic Management (CIEM), 1999. Vietnam Economy in 1998. Education Publishing House. Hanoi.

Central Institute for Economic Management (CIEM), 2000. National Accounting Framework and a Macroeconometric Model for Vietnam. Youth Publishing House. Hanoi.

Chandrasiri, Sunil, de Silva, Amala, 1996. Globalization, employment and equity: the Vietnam experience. ILO unpublished document. Available at http://www.ilo.org/public/english/region/asro/bangkok/paper/glo_viet.htm.

Cheung, Yin-Wong, Yuen, Jude, 2002. Effects of U.S. Inflation on Hong Kong and Singapore. Journal of Comparative Economics, 30. 603-619.

Dodsworth, John R., Spitäller, Erich, Braulke, Michael, Lee, Keon H., Miranda, Kenneth, Mulder, Christian, Shishido, Hisanobu, Srinivasan, Krishna, 1996. Vietnam: transition to a market economy. International Monetary Fund Occasional Paper 135.

Durevall, Dick, Ndung'u, Njuguna S., 1999. A dynamic model of inflation for Kenya, 1974-1996. International Monetary Fund Working Paper 99/97.

Engle, Robert F., Granger, Clive W.J., 1987. Cointegration and error correction: representation, estimation and testing. Econometrica 55. 251-276.

Feinberg, Robert M., 2000. The role of international discipline in three developing economies: exchange rate effects on domestic prices in Colombia, Korea and Morocco. Review of International Economics 8. 126-133.

Ghei, Nita, Pritchett, Lant, 1999, The three pessimisms: real exchange rates and trade flows in developing countries. In: Hinkle, Larry E., Montiel, Peter J., 1999, Exchange rate misalignment: concepts and measurement for developing countries, The World Bank, Oxford University Press.

Guillaumont Jeanneney, Sylviane, 1994. Macroeconomic policy to support foreign trade and economic growth. In: Guillaumont, Patrick, de Melo, Jaime, 1994. Vietnam: Policies for Transition to an Open Market Economy. UNDP-World Bank Program Country Report 13, World Bank Washington D.C.

Goldberg, Pinelopi K., Knetter, Michael M., 1997. Goods prices and exchange rates: what have we learned?. Journal of Economic Literature 35. 1243-1272.

Hendry, David F., 1995. Dynamic Econometrics. Oxford Univ. Press, Oxford, UK.

Hendry, David F., Doornik Jurgen A., 2001. PcGive 10.0 Manual. Vol.I (Empirical econometric modelling using PcGive) and Vol.II (Modelling dynamic systems using PcGive).Timberlake Consultant Ltd, West Wickham, UK.

Honohan, Patrick, Shi, Anqing, 2001. Deposit dollarization and the financial sector in emerging economies. World Bank Policy Research Working Paper 2748.

Hoffman, Dennis L., Tahiri, Chakib, 1994. Money demand in Morocco: estimating long-run elasticities for a developing country. Oxford Bulletin of Economics and Statistics 56. 305-324.

Hossein, Aktar, Chowdhury, Anis, 1998. Open-Economy Macroeconomics for Developing Countries. Edward Elgar Publishing Limited, Massachussets, USA.

International Monetary Fund (IMF). Exchange Arrangements and Exchange Restrictions (yearbooks).

International Monetary Fund (IMF). International Financial Statistics (CD-Rom).

International Monetary Fund (IMF), 1999. Vietnam: selected issues and statistical appendix. International Monetary Fund Staff Country Report 99/55 and 99/56.

International Monetary Fund (IMF), 2002. Vietnam: selected issues and statistical appendix. International Monetary Fund Country Report 02/5.

Johansen, Soren, 1995. Likelihood-based Inference in Cointegrated Vector Autoregressive Models. Oxford Univ. Press, Oxford, UK.

Johansen, Soren, Juselius, Katarina, 1990. Maximum likelihood estimation and inference on cointegration – With applications to the demand for money. Oxford Bulletin of Economics and Statistics 52. 169-210.

Jonsson, Gunnar, 1999. Inflation, money demand and purchasing power parity in South Africa, International Monetary Fund Working Paper 99/122.

Juselius, Katarina, 1992. Domestic and foreign effects on prices in an open economy: the case of Denmark. Journal of Policy Modelling 14. 401-428.

Metin, Kivilcim, 1995. An integrated analysis of Turkish inflation. Oxford Bulletin of Economics and Statistics 57. 513-532.

Nachega, Jean Claude, 2001. Financial liberalization, money demand and inflation in Uganda. International Monetary Fund Working Paper 01/118.

Reinhart, Carmen M., Rogoff, Kenneth S., Savastano, Miguel A., 2003. Addicted to dollars. National Bureau of Economic Research Working Paper 10015.

Rogoff, Kenneth S., 1996. The purchasing power parity puzzle. Journal of Economic Literature, 34. 647-668.

Sacerdoti, Emilio, Xiao, Yuan, 2001. Inflation dynamics in Madagascar, 1971-2000. International Monetary Fund Working Paper 01/168.

Sekine, Toshitaka, 2001. Modeling and forecasting inflation in Japan, International Monetary Fund Working Paper 01/82.

Sriram S. S. (2001), A survey of recent empirical money demand studies, *International Monetary Fund Staff Paper*, 47. 334-365.

State Bank of Vietnam (SBV). Annual Reports. State Bank of Vietnam, Hanoi.

Unteroberdoerster, Olaf, 2002. Foreign currency deposits in Vietnam – Trends and policy issues. In: Vietnam - selected issues and statistical appendix. International Monetary Fund Country Report 02/5.

Vo, Tri Thanh, 2000. Exchange rate in Vietnam: arrangement, information content and policy options. Individual Research Project, East Asian Develoment Network, July, Hanoi.

World Bank, 1999. Vietnam: preparing for take-off?. An Informal Economic Report of the World Bank, Hanoi, December 14-15.

Appendix A – Data and unit root tests

Table A.1 Notation of monthly series 1991:01-1999:06

Notation	Variable	Details	Source
m2-p	log(M2/CPI)	M2 = domestic currency in circulation + dong-denominated banking deposits + foreign currency deposits	SBV in SBV *Annual Reports* CIEM (2000) Vo Tri Thanh (2000) and IMF *International Financial Statistics (SFI)*
m2d-p	log(M2D/CPI)	M2D = domestic currency in circulation + dong-denominated banking deposits	
p	log(CPI)	CPI consumer price index	
y	log(IND)	IND real industrial output index	SBV in CIEM (2000) Vo Tri Thanh (2000)
e	log(TCP)	TCP Hanoi black market exchange rate	SBV *Annual Reports*
p^w	log(CPI^W)	CPI^W consumer price index of the 10 main trading partners of Vietnam: weighted mean with the share of each partner in the 1995-2000 trade: Japan (22,3%), Singapore (18,9%), Taiwan (12,9%), Korea (11,8%), China (8,7%), Hong-Kong (5,7%), Germany (5,3%), Thailand (5,2%), United-States (4,9%), France (4,4%). These 10 countries account for around 80% of the Vietnam trade.	Calculation from the author with data from IMF in *International Financial Statistics (SFI)* and *Direction of Trade Statistics (DOTS)* except for Taiwan in www.stat.gov.tw
rice	log(RICE)	RICE Export price of Vietnam rice in dollar	Osiriz *Monthly Bulletin*

Notes : Series are not seasonally adjusted.

Table A.2 Unit-root tests on monthly series 1991:07 - 1999:06
ADF-tests with constant and seasonal dummies with or without deterministic trend.

	with trend				**without trend**			
	x		Δx		x		Δx	
m2d-p	(0)	-2.085	(0)	-8.515**	(0)	-0.342	(0)	-8.568**
m2-p	(0)	-2.664	(0)	-9.065**	(0)	0.573	(0)	-9.031**
y	(0)	-5.637**			(5)	0.329	(4)	-5.964**
Δp	(0)	-4.120**			(0)	-3.816**		
Δp^w	(0)	-8.673**			(0)	-6.437**		
Δrice	(0)	-5.691**			(0)	-5.722**		
Δe	(0)	-5.480**			(0)	-5.503**		

Notes : the lag length under brackets is selected with the Akaike Information Criterion. *, ** denotes rejection of the null hypothesis of unit-root with a level respectively of 5% and 1%. Critical values used in ADF test with trend are: 5%=-3.46, 1%=-4.06; and in ADF test without trend: 5%=-2.89, 1%=-3.50.

Appendix B – I(1) cointegration analysis of the monetary sector

Table B.1 Broad money: Y ={ (m2-p), y, Δp, constant, Csais }

VECM residuals diagnostic statistics for Y_t. OLS. 1991:08 – 1999:06

	AR(1)	AR(6)	JB	ARCH(6)	H
Y	0.91 [0.51]	1.42 [0.05]	12.7 [0.05]		0.57 [0.99]
m2-p	0.82 [0.37]	1.57 [0.17]	1.39 [0.49]	1.53 [0.18]	0.62 [0.90]
y	0.48 [0.49]	1.92 [0.09]	3.62 [0.16]	1.65 [0.15]	1.54 [0.12]
Δp	0.18 [0.66]	0.84 [0.54]	7.43 [0.02]	0.28 [0.94]	0.29 [0.99]

Notes : AR(1) and AR(6) are LM tests for first-order and 1-to-6-order autocorrelation. JB is the Jarque-Bera test for normality. ARCH is an LM test for conditional heteroscedasticity. H is White's (1980) test for heteroscedasticity. Marginal significance levels are in parentheses.

Reduced-Rank Statistics.

Eigenvalues	H0: rank ≤	Trace test
0.22289	0	46.456 [0.002]**
0.13125	1	22.500 [0.022]*
0.09166	2	9.1335 [0.059]

Adjustment coefficients and standardized eigenvectors (scaled on diagonal).

α	α1	α2	α3
Δ(m2-p)	-0.03	0.15	-0.38
Δy	-0.03	-0.16	0.16
ΔΔp	0.00	-0.01	-0.22

β	β1	β2	v3
m2-p	1.00	-0.90	-0.13
y	-1.36	1.00	0.16
Δp	-3.68	-1.86	1.00
c	4.53	-2.82	-0.56

Adjustment coefficients and restricted eigenvectors.

α	α1	α2
Δ(m2-p)	-0.18 (0.04)	0
Δy	0	0.38 (0.11)
ΔΔp	0.03 (0.02)	-0.02 (0.03)

β	β1	β2
m2-p	1	0
y	-1.16 (0.05)	0
Δp	0	1
c	3.51 (0.36)	0.05 (0.02)

Notes: Standard errors of unrestricted coefficients estimates reported in (..). LR test of restrictions: Chi^2(7) = 4.10 [0.25]

Table B.2 Domestic money : Y = {(m2d-p), y, Δe, Δp, constant, Csais}

VECM residuals diagnostic statistics for Y_t. OLS. 1991:08 – 1999:06

	AR(1)	AR(6)	JB	ARCH(6)	H
Y	1.65 [0.06]	2.18 [0.00]	17.8 [0.02]		0.14 [0.99]
m2d-p	0.24 [0.62]	3.43 [0.01]	2.32 [0.31]	1.44 [0.21]	0.18 [0.99]
y	1.25 [0.26]	1.45 [0.21]	0.89 [0.63]	0.88 [0.51]	0.33 [0.99]
Δe	1.91 [0.17]	3.23 [0.01]	9.86 [0.01]	2.01 [0.08]	1.12 [0.45]
Δp	1.07 [0.30]	1.43 [0.21]	5.01 [0.08]	0.83 [0.55]	0.12 [0.99]

Notes : AR(1) and AR(6) are LM tests for first-order and 1-to-6-order autocorrelation. JB is the Jarque-Bera test for normality. ARCH is an LM test for conditional heteroscedasticity. H is White's (1980) test for heteroscedasticity. Marginal significance levels are in parentheses.

Reduced-Rank Statistics.

Eigenvalue	H0: rank ≤	Trace test
0.32956	0	94.201 [0.000]**
0.25466	1	56.218 [0.000]**
0.19937	2	28.296 [0.002]**
0.072715	3	7.4282 [0.121]

Adjustment coefficients and standardized eigenvectors (scaled on diagonal).

α	α1	α2	α3	α4
Δ(m2d-p)	-0.09	0.04	-0.02	-0.02
Δy	-0.02	-0.00	0.10	-0.01
ΔΔe	-0.02	-0.02	-0.03	-0.08
ΔΔp	0.01	0.00	0.00	-0.02

β	β1	β2	β3	v4
m2d-p	1.00	-1.23	0.52	-0.60
y	-1.42	1.00	-0.42	0.78
Δe	12.5	12.8	1.00	1.18
Δp	-7.01	-40.8	12.9	1.00
c	5.59	-0.76	0.57	-2.98

Adjustment coefficients and restricted eigenvectors.

α	α1	α2	α3
Δ(m2d-p)	-0.14 (0.03)	0	0
Δy	0	-0.12 (0.31)	0.65 (0.33)
ΔΔe	0	-0.51 (0.22)	0.28 (0.23)
ΔΔp	0	0.23 (0.06)	-0.24 (0.07)

β	β1	β2	β2
m2d-p	1	0	0
y	-1.10 (0.13)	0	0
Δe	4.72 (2.43)	1	0
Δp	10.7 (5.26)	0	1
c	3.06 (1.07)	0.02 (0.01)	0.02 (0.01)

Notes: Standard errors of unrestricted coefficients estimates reported in (..). LR test of restrictions: Chi^2(5) = 9.56 [0.08]